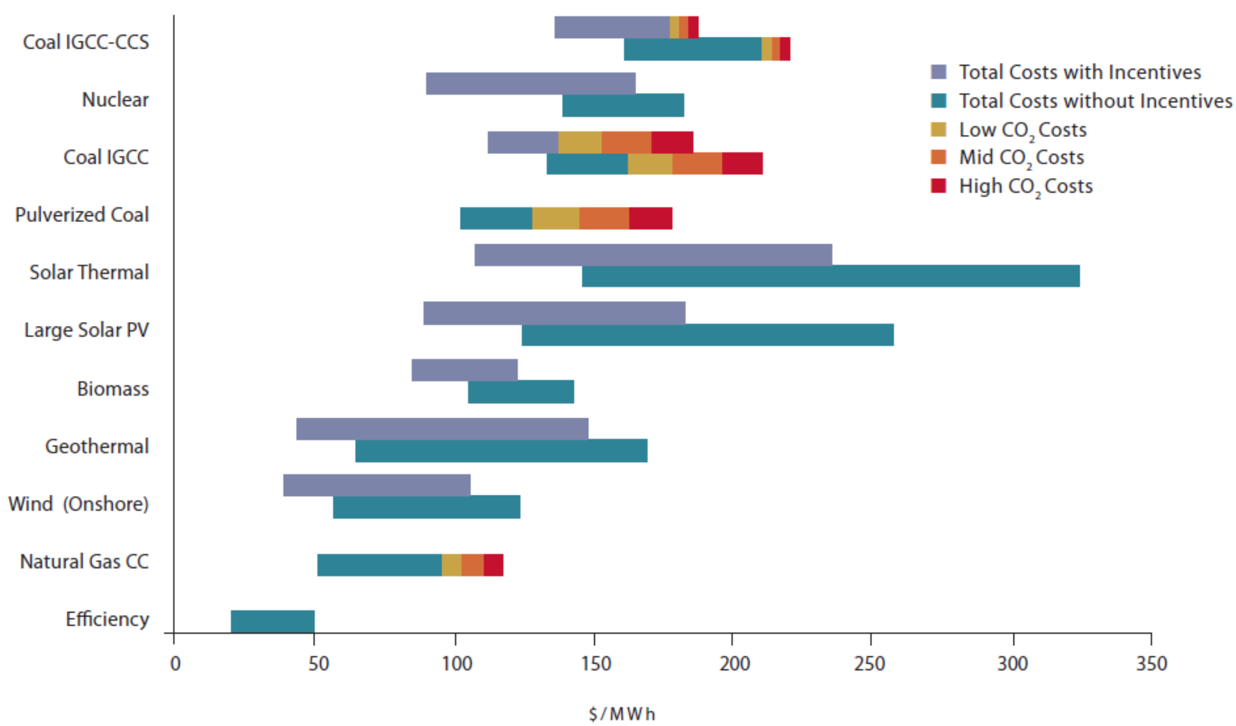
Renewable Energy Question #4: What are the predicted costs of new energy generation by type in the future? How would a carbon tax, increased carbon regulation, and the elimination of specialized tax treatment impact those cost estimates?

NOTE: This response addresses Renewable Energy Questions #4, 10 and 11 which have to do with the costs of various energy resources.

The figure below shows a range of levelized costs of generating electricity from different technologies, assumed to come on-line in 2015, with and without incentives and costs for carbon dioxide (CO_2) emissions. The data comes from a 2011 study by the Union of Concerned Scientists (UCS) called, *A Risky Proposition*: *The Financial Hazards of New Investments in Coal Plants*. It is worth noting that Energy Information Administration's (EIA) most recent levelized cost estimates for different technologies in 2018 fall within this range (EIA 2013). As defined by EIA, "levelized cost represents the present value of the total cost of building and operating a generating plant over an assumed financial life and duty cycle, converted to equal annual payments and expressed in terms of real dollars to remove the impact of inflation."

The range of costs reflects uncertainty in capital and fuel costs, as well as regional variations in costs and resource quality. The assumptions are based on project specific data, where available, and recent estimates from power plant construction and engineering firms, financial institutions, utilities, and state and federal agencies. More details on the cost and performance assumptions for each of these technologies can be found in Appendix A of the study.

Figure 1. Levelized Cost of Electricity for Various Technologies



Source: Freese et al 2011.

Without incentives and CO_2 costs (lower bars), you can see that new natural gas combined cycle (NGCC) plants, onshore wind, and the best biomass and geothermal projects are cheaper than or competitive with a new pulverized coal plant, and energy efficiency is by far the cheapest option. When you include incentives and CO_2 costs, the best large scale solar PV and concentrating solar thermal projects also become competitive. You can also see that coal with carbon capture and storage (CCS) is not competitive with other alternatives, even with incentives. And new nuclear plants are only competitive with a new coal plant when you include generous loan guarantees and other incentives or high CO_2 costs, and are more expensive than new NGCC plants, efficiency and many renewable energy technologies.

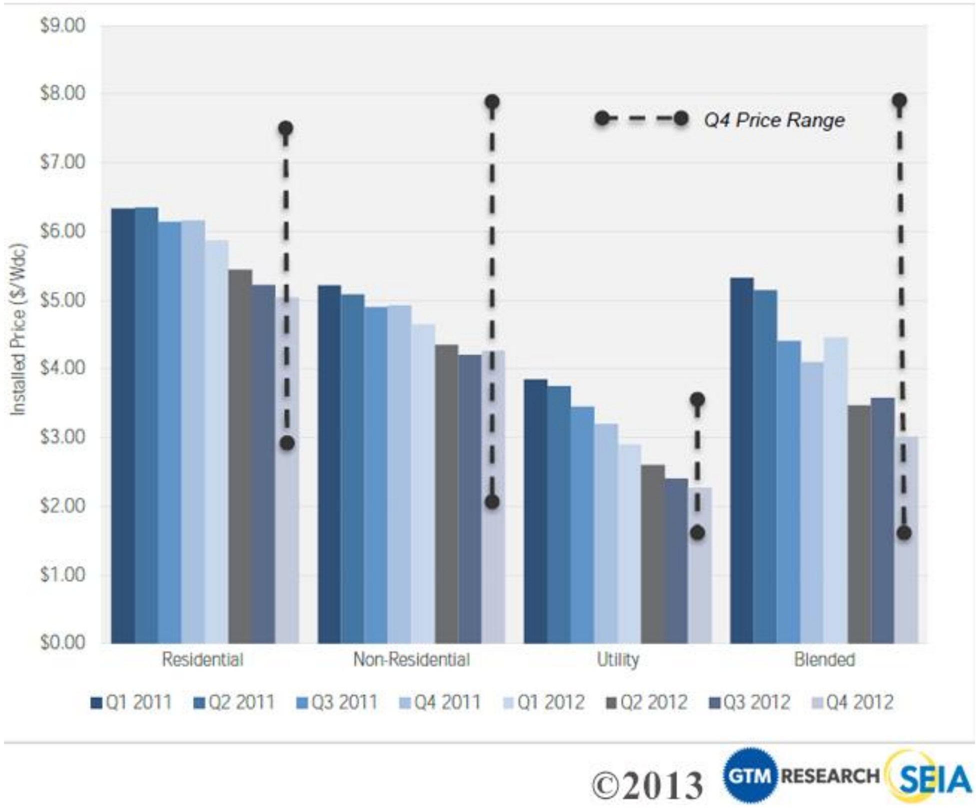
The range of future CO_2 prices assumes $13/ton in the low case, $26/ton in the mid case, and $43/ton in the high case. These estimates are based on a 2011 study reviewing more than 75 different scenarios examined in the recent modeling of various federal climate bills, as well as estimates used by a number of electric utilities in their resource plans (Johnston 2011). These prices should be considered conservative, as the report has since been updated with higher levelized CO_2 prices ranging from $23/ton to $59/ton.

The other significant changes that have occurred since the UCS study was released in 2011 are a decline in natural gas prices and the cost of wind and solar PV projects. The range of natural gas (and coal) prices used in Figure 1 are based on EIA projections from Annual Energy Outlook 2011 (AEO 2011). The recent decline in natural gas prices over the past two years is already captured in the lower end of the range in the figure. This is evident in EIA's most recent levelized cost estimate of $65.6/MWh for a new advanced NGCC plant with a 2018 in-service date (EIA 2013). The ~$20/MWh (33%) decline in average wind costs in the past three years, as shown in the response to question 3, would reduce the low end of the range of levelized wind costs in Figure 1 by approximately $10/MWh.

The cost of solar PV has also fallen dramatically over the past few years. A recent report from the Solar Energy Industries Association (SEIA) that uses a large sample of data from actual projects shows that the average installed cost of a completed PV system dropped by 27 percent over the past year, as shown in Figure 2. The study also found that the average price of a solar panel has declined by 60 percent since the beginning of 2011. These cost reductions are evident in several recent utility scale solar PV projects proposed or approved in the Southwestern U.S. that have PPA prices in the $58-$100/MWh range, including federal tax credits (Marks 2012, Bloomberg 2013). This would reduce the low end of the range for large scale PV in Figure 1 by ~$30/MWh. Significant cost reductions have also occurred for residential and commercial scale PV systems as shown in Figure 2.

While Michigan's solar resources are not as good as the Southwest, recent and projected cost reductions combined with the availability of the 30 percent federal investment tax credits through 2016 will make solar PV systems increasingly competitive with conventional and other renewable energy technologies in the state. With recent wind projects installed in Michigan in the $52-65/MWh range, wind power is already considerably cheaper than new coal plants and competitive with new natural gas power plants. And wind costs are likely to fall even further over the next few years, according to experts from Lawrence Berkeley National Laboratory (Wiser et al 2012).

Figure 2. Average Installed Price of Solar PV by Market Segment, 2011-2012



Source: SEIA 2013.

While these "levelized" costs cost comparisons are a useful screening tool for new power plants, they don't reflect the full value and costs that different technologies provide to the electricity system. For example, it doesn't include transmission and integration costs, reliability needs, the ramping flexibility that natural gas and hydro plants can provide, siting and permitting challenges, and the ability of new technologies to replace existing power plants. Figure 1 also doesn't consider changes in the future costs for different technologies. The cost of some technologies--such as wind, solar and carbon capture and storage (CCS)--are likely to decline over time with increased development, economies of scale in manufacturing, experience, and technological innovation. The cost of other technologies, such as natural gas and coal, are likely to increase as supplies become more limited and fuel prices rise over time.

Modeling recently completed by UCS [and others] that have taken these factors into account have found that it is feasible and affordable for Michigan and the U.S. to significantly increase electricity from renewable energy to much higher levels over time. For example, UCS' 2011 study *A Bright Future for the Heartland* used a modified version of EIA's National Energy Modeling System to analyze the costs and benefits of increasing renewable energy and energy efficiency in the Midwest (Martinez et al 2011). The study found that increasing renewable energy to 30 percent of the electricity mix by 2030 in Michigan and other Midwest states would lower electricity and natural gas bills in Michigan by $9 billion, when combined with investments in energy efficiency. The study also found that investing in renewable energy and efficiency would create 15,300 more jobs than using coal and natural gas to provide the same amount of electricity.

Resources:

1) Energy Information Administration (EIA). 2013. *Levelized Cost of New Generation Resources in the Annual Energy Outlook 2013*. Online at: http://www.eia.gov/forecasts/aeo/er/electricity_generation.cfm

2) Freese, B, Clemmer S., Martinez C., and Nogee A. 2011. *A Risky Proposition: The Financial Hazards of New Investments in Coal Plants.* Cambridge, MA: Union of Concerned Scientists. http://www.ucsusa.org/assets/documents/clean_energy/a-risky-proposition_report.pdf

3) Johnston, L., E. Hausman, B. Biewald, R. Wilson, and D. White. 2011. *2011 carbon dioxide price forecast.* Cambridge, MA: Synapse Energy Economics. Online at http://www.synapseenergy.com/Downloads/SynapsePaper.2011-02.0.2011-Carbon-Paper.A0029.pdf.

4) Marks, J. A. 2012. Concurrence. Case No. 11-00218-UT. *IN THE MATTER OF THE COMMISSION ESTABLISHING A STANDARD METHOD FOR CALCULATING THE COST OF PROCURING RENEWABLE ENERGY, APPLYING THAT METHOD TO THE REASONABLE COST THRESHOLD, AND CALCULATING THE RATE IMPACT DUE TO RENEWABLE ENERGY PROCUREMENTS***.** Santa Fe, NM: New Mexico Public Regulation Commission. (PDF included in Appendix).

5) Solar Energy Industries Association (SEIA) and GTM Research. 2013. U.S. Solar Market Insight Q4 2012 Report. Online at: http://www.seia.org/research-resources/us-solar-market-insight

6) Martinez, C., J. Deyette, S. Sattler, A. McKibben. 2011. *A Bright Future for the Heartland: Powering Michigan's Economy with Clean Energy*. Cambridge MA: Union of Concerned Scientists. http://www.ucsusa.org/assets/documents/clean_energy/A-Bright-Future_Michigan.pdf

7) Goossens E. and C. Martin. 2013. "First Solar May Sell Cheapest Solar Power, Less Than Coal." *Bloomberg*. http://www.bloomberg.com/news/2013-02-01/first-solar-may-sell-cheapest-solar-power-less-than-coal.html

8) Wiser, R., E. Lantz, M. Bolinger, M. Hand. 2012. *Recent Developments in the Levelized Cost of Energy from U.S. Wind Power Projects*. Online at: http://eetd.lbl.gov/ea/ems/reports/wind-energy-costs-2-2012.pdf.